UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

Note to Reader
January 8, 1998

Background: As part of its effort to involve the public in the implementation of the Food Quality Protection Act of 1996 (FQPA), which is designed to ensure that the United States continues to have the safest and most abundant food supply. EPA is undertaking an effort to open public dockets on the organophosphate pesticides. These dockets will make available to all interested parties documents that were developed as part of the U.S. Environmental Protection Agency's process for making reregistration eligibility decisions and tolerance reassessments consistent with FQPA. The dockets include preliminary health assessments and, where available, ecological risk assessments conducted by EPA, rebuttals or corrections to the risk assessments submitted by chemical registrants, and the Agency's response to the registrants' submissions.

The analyses contained in this docket are preliminary in nature and represent the information available to EPA at the time they were prepared. Additional information may have been submitted to EPA which has not yet been incorporated into these analyses, and registrants or others may be developing relevant information. It's common and appropriate that new information and analyses will be used to revise and refine the evaluations contained in these dockets to make them more comprehensive and realistic. The Agency cautions against premature conclusions based on these preliminary assessments and against any use of information contained in these documents out of their full context. Throughout this process, If unacceptable risks are identified, EPA will act to reduce or eliminate the risks.

There is a 60 day comment period in which the public and all interested parties are invited to submit comments on the information in this docket. Comments should directly relate to this organophosphate and to the information and issues available in the information docket. Once the comment period closes, EPA will review all comments and revise the risk assessments, as necessary.

These preliminary risk assessments represent an early stage in the process by which EPA is evaluating the regulatory requirements applicable to existing pesticides. Through this opportunity for notice and comment, the Agency hopes to advance the openness and scientific soundness underpinning its decisions. This process is designed to assure that America continues to enjoy the safest and most abundant food supply. Through implementation of EPA's tolerance reassessment program under the Food Quality Protection Act, the food supply will become even safer. Leading health experts recommend that all people eat a wide variety of foods, including at least five servings of fruits and vegetables a day.

Note: This sheet is provided to help the reader understand how refined and developed the pesticide file is as of the date prepared, what if any changes have occurred recently, and what new information, if any, is expected to be included in the analysis before decisions are made. **It is not meant to be a summary of all current information regarding the chemical.** Rather, the sheet provides some context to better understand the substantive material in the docket (RED chapters, registrant rebuttals, Agency responses to rebuttals, etc.) for this pesticide.

Further, in some cases, differences may be noted between the RED chapters and the Agency's comprehensive reports on the hazard identification information and safety factors for all organophosphates. In these cases, information in the comprehensive reports is the most current and will, barring the submission of more data that the Agency finds useful, be used in the risk assessments.

Jack E. Housenger, Acting Director
Special Review and Reregistration Division

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

10/29/98

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

MEMORANDUM:

Subject: Health Effects Division Reregistration Eligibility Decision Chapter for Disulfoton.

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This memorandum and six Appendices constitute the short version of the Health Effects Division Reregistration Eligibility Decision (HED RED) Document for Disulfoton. Consideration is also given to the Food Quality Protection Act of 1996 (FQPA). Attachments include the Toxicology Chapter for the Disulfoton RED (David G Anderson, Appendix 1), the most recent Hazard identification Assessment Review Committee (HIARC) Report for Disulfoton (David G Anderson, Appendix 2), the most recent Dietary Exposure Estimation Model (DEEM ^{TM}) Report for Disulfoton (Richard Griffin, Appendix 3), the Product Chemistry and Residue Chemistry Chapters for Disulfoton RED (John Abbots/Ken Dockter, Appendix 4), Occupational/Residential Exposure Chapter (ORE) for Disulfoton RED (Jonathan Becker, Appendix 5) and Memorandum from Jerome Blondell to Jonathan Becker of HED (3/25/1998), Review of Disulfoton Incidence Reports (Jerome Blondell, Appendix 5) and Water Assessment for Disulfoton RED including Drinking Water Assessment and an Draft Drinking Water Assessment for Disulfoton: Water Resources Assessment (James K Wolf, Appendix 6, Part 1 & 2, respectively).

Cumulative risk assessment from other pesticides that have a common mechanism of toxicity will be addressed in the Combined Risk Assessment for all Organophosphates Document.

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(I) EXECUTIVE SUMMARY

The risk assessment shows that disulfoton is a highly hazardous pesticide causing plasma, erythrocyte and brain cholinesterase inhibition at low dose levels. Almost all acute and chronic dietary exposures, occupational and residential exposures are unsatisfactory. The level for dietary concern for all groups occurs when dietary exposure is greater than 100% of the reference dose (RfD). The only dietary consumption that showed less than 100% of the RfD is for chronic dietary exposure for nursing infants <1 year old. The chronic dietary assessment for this group is 80% of the chronic RfD (Table E). Chronic dietary exposures for other groups ranged from 470% to 1381% of the RfD (Table E). Acute dietary exposure ranged from 840% to 1520% of the RfD for the 95% percentile (Table D). The occupational exposure assessment showed that only two types of pesticide handler activities remained with acceptable margins of exposure (MOE) (MOEs were 200 to230) when the assumption was made of base line protection or personal protective equipment (Table H). Occupational exposure is of concern if MOEs are less than 100. With engineering controls, six pesticide handler activities remain with acceptable MOEs (MOE s were 120 to 740) (Table H). Residential exposure assessment showed that only two pesticide handler activities were acceptable (MOEs were 1200 & 1900) (Table I). Residential exposure concern is indicated at less than a MOE of 300. The risk assessment for toddlers (<3 years old), potentially ingesting soil, was satisfactory for vegetable garden application sites, however the residential exposure for the pesticide handler for vegetable gardens was unsatisfactory.

The Drinking Water Level of Concern (DWLOC) is 0.8 μg/L or 8 x10^{-6} mg/kg/day for a nursing infants weighing 10 kg and drinking 1 L of water per day; the only group for which a DWLOC could be calculated. Since all other dietary group assessments were greater than 100% of the RfD, any concentrations of disulfoton in drinking water would be unacceptable.

Tolerances for disulfoton residues were reassessed and ranged from 0.01 ppm for milk to 5.0 ppm for oats and wheat fodder.

An acute delayed neurotoxicity study in hens with a neurotoxic enzyme (NTE) study is required. There are several requirements for product chemistry, tolerance assessments and recommendations for tolerance revocations.

Some minor revisions in the tolerance expression are required for harmonization with Codex. Tolerances that are currently expressed as demeton-S should be expressed as disulfoton.

(1) Background

Three disulfoton manufacturing-use products (MPs) are registered under Shaughnessy No. 032501 to Bayer Corporation: the 98.5% technical (T; EPA Reg. No. 3125-183) and the 68% and 2% formulation intermediates [FIs(Formulation Intermediate); EPA Reg. Nos. 3125-158 and 3125-128, respectively]. We note that REFS identifies the 2% FI as an end-use product; however, the label (dated 6/16/94) states that the product is for repackaging only. This product is correctly identified as an MP. Only the Bayer 98.5%, 68%, and 2% disulfoton MPs are subject to a reregistration eligibility decision.

Disulfoton is an organophosphate insecticide/arachnicide. It is formulated as the 15% granular for use on grains, cotton, sorghum, peanuts, soybeans, tobacco, coffee, non-bearing fruit trees, pecans, vegetables, flowers, shrubs, trees and ground-covers; as the 8% Emulsifiable Systemic for use on grains, grains, cotton, sorghum, tobacco, non-bearing fruit trees, pecans and vegetables; as the 95% Seed Treatment for use on cotton, as the 1%, 2% 5% and 10% Systemic Granules for use on flowers, shrubs, home garden vegetables & greenhouses.

(2) Hazard Characterization

Disulfoton is classified as acutely toxic, toxicity category I, by the oral, dermal and inhalation routes. Disulfoton was too toxic for guideline studies on primary eye, skin irritation and dermal sensitization to be conducted. The data requirements were waived because of the severity of the anticipated results and the most severe categories should be assumed for eye and skin irritation.

The mode of action of disulfoton is inhibition of cholinesterase. In all of the studies evaluated in this hazard assessment, the LOEL and NOEL were established through the inhibition of cholinesterase (the basis for all regulatory endpoints). Clinical signs, such as muscle fasciculation and tremors are seen either at higher dose levels or at the LOEL for some studies. All three cholinesterases (plasma, erythrocyte and brain) are inhibited at the lowest dose tested and are likely to occur across species. There are slight species differences, but the differences may be due to normal variation and differences in the duration of the studies conducted in different species. Adult females appear to be slightly more sensitive than males. In a 6-month study in rats (MRID# 43058401), cholinesterase inhibition was seen only in females.

The cholinesterase endpoints between acute and chronic studies in rats all are within a 10 fold exposure level. Longer exposure always showing cholinesterase inhibition at lower dose levels. Clinical signs occurred at the same dose level as cholinesterase inhibition in the acute neurotoxicity study, whereas in the 90-day neurotoxicity study, cholinesterase inhibition occurred at a lower dose level. Motor activity was affected at lower dose levels in the 90-day study than in the acute study, but no treatment related or significant neuropathology occurred either acutely or in the 90-day studies.

There is no increased susceptibility to fetuses or pups in acceptable developmental and reproductive toxicity studies in the rabbit or rat. Pup death occurred at the highest dose tested. The deaths were attributed to an inadequate milk supply and maternal care failure. In the developmental toxicity study in the rat, developmental toxicity occurred at higher doses than caused toxicity in dams. Developmental toxicity in the rat was seen in the form of incomplete ossification, but no developmental toxicity was seen in the rabbit at the dose levels administered. In the study on reproduction, cholinesterase was inhibited (plasma, erythrocyte and brain) in parents at lower dose levels than in pups.

No obvious endocrine disruption was seen in any of the studies. Absolute testes and ovarian weights were decreased (of unknown cause) at the highest dose levels and in the presence of cholinesterase inhibition in the chronic rat study, which may be endocrine mediated. However, these could not be unequivocally attributed to endocrine effects.

There is an adequate dermal absorption study in rats and an adequate 21-day dermal study in rabbits showing cholinesterase inhibition (plasma, erythrocyte and brain).

There are no carcinogenicity concerns in two acceptable studies in the rat and mouse. An adequate dose level was reached in the study in rats to test the carcinogenic potential of disulfoton, based on decreased body weights and body weight gains. In mice, the highest dose tested in this study is approximates 35% of the LD_{50} and higher dietary concentrations would have resulted in significant compound-related mortality of the test animals. Thus, the dose levels were considered adequate to test the carcinogen potential of disulfoton in mice.

Disulfoton is positive in some mutagenicity studies without activation, but negative or weakly positive in most with activation. With no carcinogenicity concerns and no reproductive toxicity concerns at relevant dose levels, the mutagenicity concerns are low. The mutagenicity data base is complete for the pre-1990 required three mutagenicity categories and the *in vivo* data base support a lack of concern for the mutagenicity of disulfoton.

The metabolism of disulfoton was studied in the rat. It was found to be rapidly absorbed and excreted with over 95% of the administered C^{14} labeled disulfoton being recovered in the urine and

approximately 90% excretion within 24 hours. Less than 2% was recovered from the feces. Bioaccummulation was not observed with less than 0.3% being recovered in tissues and less than 1% being recovered in the carcass. A major metabolite was incompletely identified, but it co-chromatographed with 1-(ethylsulfonyl)-2-(methylsulfonyl)ethane, a fully oxidized form of the putative hydrolysis product. The toxic metabolites of disulfoton are disulfoton sulfoxide, disulfoton sulfone, disulfoton oxygen analog (demeton-S), disulfoton oxygen analog sulfoxide and disulfoton oxygen analog sulfone. The Metabolism Committee determined that the residues to be regulated in plant and animal commodies are disulfoton, disulfoton oxygenated analog and their sulfoxides and sulfones.

(3) Quality of the Toxicity Data Base

The toxicity data base for disulfoton is adequate to support reregistration. The data base is of generally high quality with better than average consistency in data on the dose and treatment relationship of plasma, erythrocyte and brain cholinesterase inhibition which are the regulatory endpoints of concern.

All the toxicity data used to select endpoint for regulation were acceptable guideline studies. The only data gap is an acute delayed neurotoxicity study in hens, guideline §870.6100. The available study was equivocal and determined to be unacceptable and an additional study (870.6100) is required. The latter study guideline also gives guidance for conducting the neurotoxic esterase (NTE) component, which is also required. However, the HIARC indicated that the studies would be considered confirmatory.

(4) Dose Response

All the NOELs and LOELs selected for regulation of disulfoton were based on a dose response relationship with the endpoints selected from the relevant studies. The Health Effect Division (HED) Hazard Identification Assessment Review Committee (HIARC), evaluated the toxicity data base for disulfoton, established an acute Reference Dose (RfD), a chronic RfD and selected endpoints for short term, intermediate term and long term occupational and residential exposure (Table A and B). A dose response relationship or at least a treatment related effect is considered a prime reason for the endpoints selection process by the HIARC.

The HED Food Quality Protection Act (FQPA) Safety Factor Committee evaluated the toxicity data and exposure data and determined that the 10X uncertainty (UF) factor required by FQPA under certain circumstances should be reduced to 3X. The reasons include equivocal results from the acute delayed neurotoxicity study in hens, nominal increases in potential neuropathology in other studies and uncertainties about the need for a developmental neurotoxicity study. FQPA requires an additional 10X UF on food residues and residential exposure unless safety can be assured. Thus, a total UF of 300 is used for food residues and residential exposure in the assessment of disulfoton (10X for intraspecies variation, 10X for interspecies variation and 3X for the above data uncertainties). Table A shows acute and chronic endpoints, RfDs and required MOEs. Table B shows the residential endpoints and required MOE Table C shows the occupational exposure endpoints and required MOEs.

Table A: The doses and toxicological endpoints selected and Margins of Exposure for acute dietary and chronic dietary exposure are summarized in this Table.

Exposure scenario	NOEL [1]	Endpoint	Study	Uncertainty Factor
Acute dietary	0.25 mg/kg/day	Cholinesterase/clinical signs	Acute neurotox/rat (81-8)	300
Acute dietary RfD = 0.00083 mg/kg (FQPA population adjusted dose)				
Chronic dietary	0.013 mg/kg/day	Cholinesterase	Chronic/Dog (83-1)	300
Chronic dietary RfD = 0.000043 mg/kg/day (FQPA population adjusted dose)				

Table B: Endpoints for Residential exposure scenarios and MOEs

Exposure scenario	NOEL 1	Endpoint	Study	MOE required
Short-term (dermal)	0.4 mg/kg/day	Cholinesterase	21-day dermal/rabbit (82-3)	300
Correction for dermal absorption unnecessary				
Intermediate-term (dermal)	0.03 mg/kg/day [2]	Cholinesterase	6-months oral chronic/rat(NG)	300
Correction for oral to dermal exposure necessary				
Long-term life time (dermal)	0.013 mg/kg/day [2]	Cholinesterase	Chronic oral/dog(83-1)	300
Correction for oral to dermal exposure necessary				
All Time Periods Short-Intermediate and Long-term (inhalation)	0.00016 mg/L [2]	Cholinesterase	90-day inhal/rat(82-4)	300

[1] = No Observed Effect Level.
[2] = Appropriate route-to-route extrapolation should be performed for these risk assessments (i.e., dermal and inhalation exposure components using absorption rates of 36% and 100%, respectively, should be converted to equivalent oral dosages and compared to the oral NOELs).

Table C: The doses and toxicological endpoints selected and Margins of Exposure for Occupational exposure scenarios are summarized in the table below.

Exposure scenario	NOEL	Endpoint	Study	MOE required [1]
Occupational exposure				
Short-term (dermal)	0.4 mg/kg/day	Cholinesterase	21-day dermal/rabbit (82-3)	100 [1]
Correction for dermal absorption unnecessary				
Intermediate-term (dermal)	0.03 mg/kg/day [2]	Cholinesterase	6-months chronic oral/rat(NG)	100 [1]
Correction for oral to dermal exposure necessary				
Long-term life time (dermal)	0.013 mg/kg/day [2]	Cholinesterase	Chronic oral/dog(83-1)	100 [1]
Correction for oral to dermal exposure necessary				
All Time Periods Short- Intermediate and Long-term (inhalation)	0.00016 mg/L [2]	Cholinesterase	90-day inhal/rat(82-4)	100 [1]

[1] = Required margin of exposure for all occupational exposures is 100
[2] = Appropriate route-to-route extrapolation should be performed for these risk assessments (i.e., dermal and inhalation exposure components using absorption rates of 36%and 100%, respectively, should be converted to equivalent oral dosages and compared to the oral NOELs).

(5) Dietary Exposure Estimates from Food Sources

The acute and chronic dietary risk estimates used the Dietary Exposure Estimation Model (DEEM™) software and USDA 1989 -1992 food consumption data.

(1) Acute Dietary Risk: The Tier 1 acute dietary risk was calculated with the aid of DEEM™ using reassessed, tolerance-level residues and 100% crop treated. The acute risk that ranged from eight to 15 times the RfD at the 95% percentile. All infants (<1 year old) were 10 times the RfD and children (1-6 years old) were 15 times the RfD at the 95% percentile. For these risk numbers the 95% percentile is the appropriate percentile to use. The 95%, 99% and 99.9% percentiles are listed in Table D for comparison.

Table D: Summary of acute dietary risk for US population and infants and children as modeled[a] by DEEM™.

	Percentage of the RfD[b]		
Percentile	95%	99%	99.9%
U.S. population all seasons	840%	1388%	2212%
All infants (<1 year old)	958%	1595%	2296%
Children (1-6 years old)	1520%	2177%	2924%

[a] Adjustment factor# 2 not used (Not adjusted for % crop treated or field trial data on potatoes)
[b] Acute RfD = 0.00083 mg/kg/day (FQPA population-adjusted dose)

(2) Chronic Dietary Risk: The Chronic dietary risks using DEEM™ were based on reassessed tolerance-level residues for all commodities (except potatoes and meat and milk) and percent crop treated data from BEAD prepared by Steven Nako (6/18/97). Anticipated residues for potato commodities were based on average field trial data. For livestock commodities, anticipated residues were based on transfer ratios from livestock feeding studies and livestock dietary burdens adjusted for percent crop treated (John Abbotts, 9/17/97). The chronic dietary risk greatly exceeds the Agency's level of concern for the U.S. population and all population subgroups except nursing infants (<1 year old) where risks are 80% of the RfD. Chronic dietary risk estimates were 648% of the RfD for the general U.S. population and 1,382% of the RfD for the most highly exposed subgroup, children 1-6 years old (Table E). Succulent green beans contribute the greatest dietary burden to the chronic risk for the U.S. population (208% of the RfD) and for all infants <1 year (588% of the RfD). The calculated risks are based upon a chronic RfD of 0.000043 mg/kg/day (FQPA population-adjusted dose). The Agency considers an RfD greater than 100% to be a risk concern.

Table E: Summary of chronic dietary risk as modeled by DEEM ™ and based on a RfD = 0.000043 mg/kg/day (FQPA population-adjusted dose).

Population subgroup	Anticipated allowable daily concentration (mg/kg/day)	% of RfD [a]
U.S. population, 48 states, all seasons	0.000278	648 [b]
U.S. population, spring, summer, autumn & winter	0.000262 to 0.000293	610
Region, North East, Mid-West, Southern, Western, Pacific	0.000247 to 0.000297	575
Hispanics, non hispanic whites, non hispanic blacks & other	0.000213 to 0.000306	495
All infants (<1 year)	0.000253	588
Nursing infants (<1 year)	0.000035	80
Non nursing infants (<1 year)	0.000344	801
Children (1-6 years)	0.000594	1382
Children (7-12 years)	0.000374	870
Female (13-19 yrs/not preg. or nursing)	0.000214	498
Female (20+ years/not preg. or nursing)	0.000238	554
Females (13-50 years)	0.000220	512
Females (13+ /pregnant/not nursing)	0.000202	547
Females (13+ /nursing)	0.000274	637
Males (13-19 years)	0.000237	550
Males (20+ years)	0.000222	516
Seniors (55+)	0.000259	602

[a] %RfD = [(dietary exposure)/RfD]X100; [b] Data should be rounded off to one significant figure.

(6) Dietary Exposure from Drinking Water Sources

Potential exposure to disulfoton in drinking water was assessed using modeling and limited monitoring data provided by EFED (James Wolf, 12/15/97).

Surface Water: A Tier 2 assessment was conducted using PRZM3/EXAMS modeling for disulfoton applied to barley, cotton, potatoes, tobacco, and spring wheat at the upper 10th percentile and maximum registered application rates. The maximum peak concentration of parent disulfoton was 117 μg/L and the maximum 60-day average concentration was 94 μg/L .

Ground Water: The Sci-Grow (Screening Concentrating in Ground Water) screening model was used to estimate potential found water concentrations for disulfoton parent. At the maximum application rate, the maximum predicted disulfoton ground water concentration was 0.83 μg/L.

The fate of disulfoton in surface and ground water and the likely concentration cannot be modeled with a high degree of certainty since no data are available for the aerobic and anaerobic aquatic degradation rates and anaerobic soil metabolism. The environmental fate and chemistry data base for disulfoton is incomplete for the parent compound. Fate data are not available for the degradation products. The major routes of dissipation are microbial degradation in an aerobic soil and aqueous photolysis and soil photolysis. The overall results of these mechanisms of dissipation appear to indicate that disulfoton has low to moderate persistence in the environment. Limited data suggested that the degradates are much more persistent.

Monitoring Data: Surface water monitoring data collected by the USGA as part of the National Water Quality Assessment (NAWA) program was also considered (Table F). Disulfoton residues were found in 10 out of 2700 surface water samples. Maximum concentrations were 0.002 μg/L and 0.007-0.041 μg/L in integrated streams/agricultural wells and urban/agricultural streams, respectively. There were no reported detections in about 2200 ground water samples (wells and aquifers). The USGS data in limited in that there are no data on disulfoton use in the area surveyed. In addition, methods with different limits of detection were used and there is no data on the hydrogeography of the sites monitored. However, since agricultural streams contained the highest level detected, some disulfoton use must have occurred in the area monitored.

Table F. Summary of Detections in USGS NAQWA Study (USGS, 1997[1]).

Water Source	%> 0.01 µg/L	Maximum Concentration (μg/L)
Agricultural Streams	0.2	0.041
Urban Streams	0.0	0.007
Integrated Streams	0.0	0.002
Agricultural Wells	0.0	0.002
Urban Wells	0.0	None
Major Aquifers	0.0	None

[1] USGS, 1997 NAQWA, (URL http://water.wr.usgs.gov/pnsp/gwswl.html, August 1997); Gilliom, R.J., W.M. Alley, and M.E. Gurtz, 1995, Design of the National Water-Quality Assessment Program: Occurrence and Distribution of Water-Quality Conditions, U.S. Geological Survey Circular 1112, 33 p.; USGS. 1997. Pesticides in Surface and Ground Water of the United States: Preliminary Results of the National Water Quality Assessment Program(NAWQA) August 1997. Pesticides National Synthesis Project, National Water-Quality Assessment, U.S. Geological Survey

(7) Occupational/Residential Risk Estimates

Only two exposure scenarios had margins of exposure greater than 100 using baseline data with no personal protective equipment (PPE) or engineering controls (EC) (Table G). These same two exposure scenarios were also the only ones acceptable when personal protective equipment (PPE) was assumed to be used (Table G). These were loading and applying granular disulfoton by tractor-drawn spreader for nut trees. When engineering controls were applied, six activities had MOEs greater than 100 (Table G). These were: (1) loading granulars for aerial application to barley at 1 lb a.i./acre, short term only (MOE is 170), (2) loading granulars for aerial application to potatoes at 4 lb a.i./acre, short-term only (MOE is190), (3) loading granulars for tractor drawn spreader applications to cabbage at 1 lb a.i./acre, short-term and intermediate-term (MOEs are740 & 310), (4) loading granulars for tractor drawn spreader applications to non-bearing fruit trees at 102 lb a.i./acre, short-term and intermediate-term (MOEs are 290 & 120), (5) loading granulars for tractor drawn spreader application to flower/ground cover at 28.6 lb a.i./acre, short-term and intermediate-term (MOEs are 1000 & 440), (6) applying sprays with a groundboom at 0.5 lb a.i./acre to sorghum, short-term only (MOE is130), and (6) applying granulars with a tractor drawn spreader to flowers/groundcover at 28.6 lb. a.i./acre, short-term only (MOE is 120) (Table G). For occupational exposures a MOE of <100 is unacceptable.

The only residential uses that had an acceptable MOE were using a push type spreader for granular disulfoton spreading on flower gardens at 0.0005 lbs. ai per 1000 ft^2 and to ornamental shrubs/small trees, 0.00032 lb. a.i./4 ft shrub. MOEs were 1,900 and 1,200, respectively (Table H). There were no data on exposure through the use of disulfoton spikes or post application exposure when disulfoton was used to treat small trees and shrubs. (Short term residential exposures for inhalation and dermal exposures only were assumed.) The reentry calculations indicated that a person could safely enter the area of application only after 34-35 days for pruning and harvesting of flower gardens (Table I). For residential exposures including toddlers a MOE of less than 300 is unacceptable.

The data for toddlers (3 years old) potentially ingesting soil around residential application sites showed a marginally unsatisfactory MOE of less than 300, MOE was 230 for flower beds and a satisfactory MOE of 612 for vegetable gardens (Table J). However, the MOEs for a residential handler of granulars for vegetable gardens were unsatisfactory MOE of 8.2 for the loading/applying with a push type spreader at the lowest recommended rate and with a spoon, shaker can or measuring scoop, MOE of 0.06. Thus, since treatment of flower gardens treated at the higher rate and vegetable gardens have an unsatisfactory residential MOE and potential soil ingesting toddlers need not be considered if these areas are not treated. No residential exposure was assumed for nursing infants (<1 year old).

The use of disulfoton for residential use in flower beds is unrealistic and impractical since the reentry period is greater than 1 day (reentry period is 24-35 days).

Table G: Occupational handler exposure MOEs for Short-Term (S-T) and Intermediate-Term (I-T) with baseline, PPE and engineering controls (EC) as indicated. Data extracted from the Occupational and Residential Exposure Assessment for Disulfoton (Appendix 5)

Exposure scenario	Crop application rates	Risk mitigation level & acceptable MOE [a]	Data Confidence [b]	Total MOE (S-T)[c]	Total MOE (I-T)[c]
All uses except as indicated below	All rates	Baseline MOE=100	L to H	0.009 to 34	0.002 to 9.5
Nut trees, loading or applying granular with a tractor-spreader	All rates	Baseline MOE=100	L	200 to 230	80 to 84
All except as indicated below	All rates	PPE added MOE=100	L to H	1.4 to 18	0.3 to 3.9
Loading or applying granulars with tractor-spreader		PPE added MOE=100			
Cabbage	1 lb a.i./acre		L	54-55	16-18
Flowers/ground cover	28.6 lb a.i./acre		L	77	22
Nut trees	3 lb a.i./acre		L	NA to NA [d]	210 to 240
All uses except as indicated below		EC added MOE=100		1.6 to 33	0.4 to 11
Mixing/load EC for ground boom application		EC added MOE=100			
Wheat	1 lb a.i./acre		M to H	37	8.3
Sorghum	0.5 lb a.i./acre		M to H	75	17
Loading granulars for aerial application		EC added			
Cotton	2 lb a.i./acre	MOE=100	L	85	36
Barley	1 lb a.i./acre		L	170	72
Loading granulars for tractor-spreader application		EC added MOE=100			
Raspberries	8 lb a.i./acre		H	93	39
Potatoes	4 lb a.i./acre		H	190	78
Cabbage	1 lb a.i./acre		H	740	310
Nut trees	3 lb a.i./acre		H	NA	NA
Non-bearing fruit trees	102 lb a.i./acre		H	290	120
Flowers/ground cover	28.6 lb a.i./acre		H	1000	440
Applying sprays with a helicopter		EC added			
barley	1 lb a.i./acre	MOE=100	L to very L	42	8.8
sorghum	0.5 lb a.i./acre		L to very L	84	18
Applying spays with a ground boom		EC added			
sorghum	0.5 lb a.i./acre	MOE=100	M	130	29
Applying granulars for tractor-spreader		EC added			
Cabbage	1 lb a.i./acre	MOE=100	H	86	29
flowers/ground cover	28.6 lb a.i./acre		H	120	41

[a] = Level of mitigation & acceptable MOE; [b] = Confidence in the exposure data, H=high, M=medium, L=low; [c] = Total short term & intermediate exposure (dermal and inhalation); [d] = NA = Not Applicable

For convenience and summary purposes in Table G, the confidence level was chosen from the dominant exposure data base (dermal or inhalation). The confidence (low, medium or high) level for both dermal and inhalation was considered to be the confidence level of the data that dominated the MOE. The confidence level was considered separately for inhalation and dermal MOEs if neither dominated the MOE, however few exposure scenarios had MOEs for inhalation and dermal exposures approximately equal and fewer demonstrated differences in the confidence levels for the dermal and inhalation data when neither were dominant. (Additional details can be found in Appendix 5, Table 3.)

Table H: Residential handler exposure MOEs for Short-Term (S-T).

Type of Protection	Crop application rate	Risk mitigation level & acceptable MOE [a]	Confidence in exposure data [b]	Total MOE(S-T)[c]
All uses except as indicated		Baseline Acceptable MOE=300	L	0.002 to 99
Loading/ applying granular with a push type spreader		Baseline Acceptable		
Roses	0.0018 lb a.i./bush	MOE=300	L	99
flower gardens	0.1 lb a.i./1000 ft^2)		L	93
Flower gardens	0.005 lb a.i./1000 ft^2)		L	1900
Ornamental shrubs/small trees	0.00032 lb a.i./4 ft shrub		L	1200
Application of insecticidal spikes		Baseline Acceptable MOE=300		NA

[a] = Level of protection and acceptable MOE; [b] = Confidence in the exposure data, H=high, M=medium, L=low; [c] = Total short term exposure (dermal and inhalation); [d] = NA = Not Applicable

Table I: Residential exposure post application

Low growing field crops applied at 4.9 lb a.i./acre						Weeding , pruning flower gardens applied at 13 lb a.i./acre					
DAT[a]	DFR [b]	Non-harvesting		Harvesting		DAT[a]	DFR [b]	Non-harvesting		Harvesting	
		Dermal dose [c]	MOE	Dermal dose [c]	MOE			Dermal dose [c]	MOE	Dermal dose [c]	MOE
0	5.5	0.085	0.4	0.20	0.2	0	15	1.5	0.02	0.15	0.2
18	0.031	0.00048	63	0.0011	27	20	0.046	0.0048	6	0.00048	63
24	0.055	0.000085	350	0.00019	150	26	0.0082	0.00085	35	0.000084	350
27	0.002 3	NA	NA	0.000084	360	34	0.00082	0.000085	350	NA	NA

[a] = DAT= days after treatment. [b] = Initial DFR is application rate x conversion factor (lb a.i./acre = 11.209 μg/cm^2) x fraction of the initial a.i. retained on foliage. [c] = Dose is in mg/kg/day.

Table J: Residential postapplication risk from incidental soil ingestion of disulfoton for toddlers 3 year old.

Scenario	Application rate per treatment (AR) (lbs a.i./acre) [a]	SRt (μg/g) [b]	IgR (mg/day)	Body weight (kg)	ADD (mg/kg/day) [c]	MOE [d]
Incidental soil ingestion (Flower beds)	13	20	100	15	0.00013	230
Incidental soil ingestion (Vegetable garden beds)	4.9	7.4	100	15	0.000049	612

a = Application rate for flower and vegetable gardens
b = Soil residue (μg/g) = [AR (lbs ai/acre) x 4.54E+8μg/lb x 2.47E-8 A/cm^2 x 0.67 cm^3/g soil x 0.2/cm]
c = Average daily dose (ADD)(mg/kg/day) = [SRt (μg/g) 8 IgR (mg/day) x g/(l,000,000 μg)]/[body weight (kg)].
d = MOE = NOEL (0.03 mg/kg/day)/ADD. SRt = Soil residue on day "t" (μg/g), assuming average day of re-entry "t" is day 0. IgR = ingestion of soil (mg/day), assumed to be 100 mg/day.

(8) Aggregate Risk (Food, Water and Residential)

There is a potential for exposure of the general public (adults and children) to residues of disulfoton through its residential use in home ornamental and vegetable gardens and through food and drinking water sources. Dietary exposure through food is the major contributor to the aggregate risk estimates.

Acute Aggregate Risk: Acute aggregate risk estimates exceed HED's level of concern. The Tier 1 (95% percentile) acute dietary risk estimates for all populations from food alone greatly exceeds HED's level of concern. Any level of exposure to disulfoton residues through drinking water would only contribute more to an already unacceptable risk estimate from food. Thus, the drinking water level of comparison (DWLOC) is, in effect, zero. Tier 2 (PRZM/EXAMS) estimates of disulfoton in surface waters from conservative screening models indicate concentrations of around 94 μg/L.

Chronic Aggregate Risk: Chronic dietary risk estimates exceed HED's level of concern for the U.S. population and all population subgroups except nursing infants (<1 year old) where risks are 80% of the RfD. No chronic residential use scenarios were identified for disulfoton. Since there is no contribution to chronic aggregate risk from residential use, aggregate risk estimates include only exposure through food and water. HED has calculated a drinking water level of comparison (DWLOC) for nursing infants (<1 yr) of 0.08 μg/L (Table K). The estimated average concentration of disulfoton is 43 μg/L in surface water (Tier 2 PRZM/EXAMS), 0.83 μg/L in ground water (SCI-GROW). Both ground and surface water model estimates predict levels of disulfoton greater that the DWLOC for nursing infants (<1yr). Limited data are available from the 1997 USGS survey data which indicate a maximum concentration of 0.041 μg/L in agricultural streams. Because the USGS 1997 data have a number of limitations, they cannot be used with reasonable certainty to estimate the contribution to the dietary risk of infants from drinking water sources.

Table K: DWLOC for the nursing infants (<1year)							
Population	PRZM-EXAMS (μg/L)	SCI-GROW (μg/L)	RfD (mg/kg/day)	Chronic Food Exposure (mg/kg/day)	Chronic Residential Exposure (mg/kg/day)	Chronic H_2O Exposure (mg/kg/day)	$DWLOC_{chronic}$ (μg/L)
Nursing Infants (<1 yr)	94	0.83	0.000043	0.000035	0	0.0000080	0.08

Short-term Aggregate Risk: Short-term aggregate risk estimates exceed HED's level of concern. Aggregate risk estimates associated with short-term risks include exposure to average residues of disulfoton in the diet (food and water) and dermal and inhalation exposure (1 to 7 days in duration) through the residential application of disulfoton. The aggregate risk assessment includes exposure to average concentrations of disulfoton residues in the diet from commodities with existing tolerances (from the DEEM^{TM} analysis), and the high-end exposure scenario associated with homeowners applying disulfoton with a push-type spreader. Since average concentrations of disulfoton residues in the diet alone exceed HED's levels of concern, any level of exposure from residential uses would only contribute more to an already unacceptable risk estimate from food.

(9) Tolerance Reassessment

The Residue Chemistry Chapter for the disulfoton RED lists the reassessed tolerances and recommends that some tolerances be revoked. The reassessed tolerances range from 0.01 ppm for milk to 5.0 ppm for oats and wheat green fodder. It was recommended that tolerances be revoked for alfalfa fresh and hay, sugar beets roots and tops, sugar beet pulp, pineapple bran, clover, fresh and hay, pop corn forage, hops, peanut hulls, pineapples and foliage, rice and rice straw, spinach and sugarcane. (See Residue Chemistry Chapter of the Disulfoton RED, page 51, Appendix 4).

(10) Required Data

The only toxicity study required for confirmatory purposes is an acute delayed neurotoxicity study with an NTE study. There are requirements for product chemistry and several for tolerance assessments and recommendations for tolerance revocation (See the Appendix 4: Residue Chemistry Considerations for the Disulfoton RED).

(11) Human Incidence Data)

Human data contained in a memorandum from Jerome Blondell to Jonathan Becker of HED (3/25/1998), Review of Disulfoton Incidence Reports, show that disulfoton was 11th among the 28 pesticides reported (1982-1989)(28 pesticides with the highest reported incidence rates) and had the highest ratio for cases when the pesticide was considered the primary cause of poisoning of field workers per 1000 applications. Disulfoton ranked third on percentage of occupational Poison Control Center cases requiring hospitalization and fourth among these 28 pesticides studied on percentage of occupational cases with life-threatening symptoms. Death (including suicides and possible homicides) confounded by misuse is known to infrequently occur; however, no other permanent disability has been adequately documented. The excessive exposure was up to 1381% of

the chronic RfD, 1520% of the Acute RfD and disulfoton handler exposure risks are as low as MOE = 0.002.

(12) Codex

The Codex MRLs are expressed in terms of the sum of disulfoton, demeton-S, and their sulfoxides and sulfones expressed as disulfoton. Some US tolerance are still expressed in terms of demeton-S. However, since the molecular weight of disulfoton is only 6% lower than demeton-S, the difference is small. Codex MRLs and the U.S. tolerances will be compatible when the U.S. tolerance expression is revised to include disulfoton, its oxygen analog, and their sulfoxides and sulfones, calculated as disulfoton.

(II) APPENDICES

Appendix 1 - Toxicology Chapter for the Disulfoton RED.
(David G Anderson)

Appendix 2 - The Hazard Identification Assessment Review Committee Report for Disulfoton.
(David G Anderson)

Appendix 3 - The Dietary Exposure Estimation Model (DEEM^{TM}) Report for Disulfoton
(Richard Griffin)

Appendix 4 - Product Chemistry and Residue Chemistry Chapters for the Disulfoton RED
(John Abbots/Ken Dockter)

Appendix 5 - Occupational/Residential Exposure Chapter for the Disulfoton RED
(Jonathan Becker).
and
Memorandum from Jerome Blondell to Jonathan Becker of HED (3/25/1998), Review of Disulfoton Incidence Reports.
(Jerome Blondell)

Appendix 6 - Water Assessment for the Disulfoton RED, Including a Drinking Water Assessment (Part 1) and an updated Draft Drinking Water Assessment for Disulfoton: Water Resources Assessment (Part 2)
(James K Wolf)